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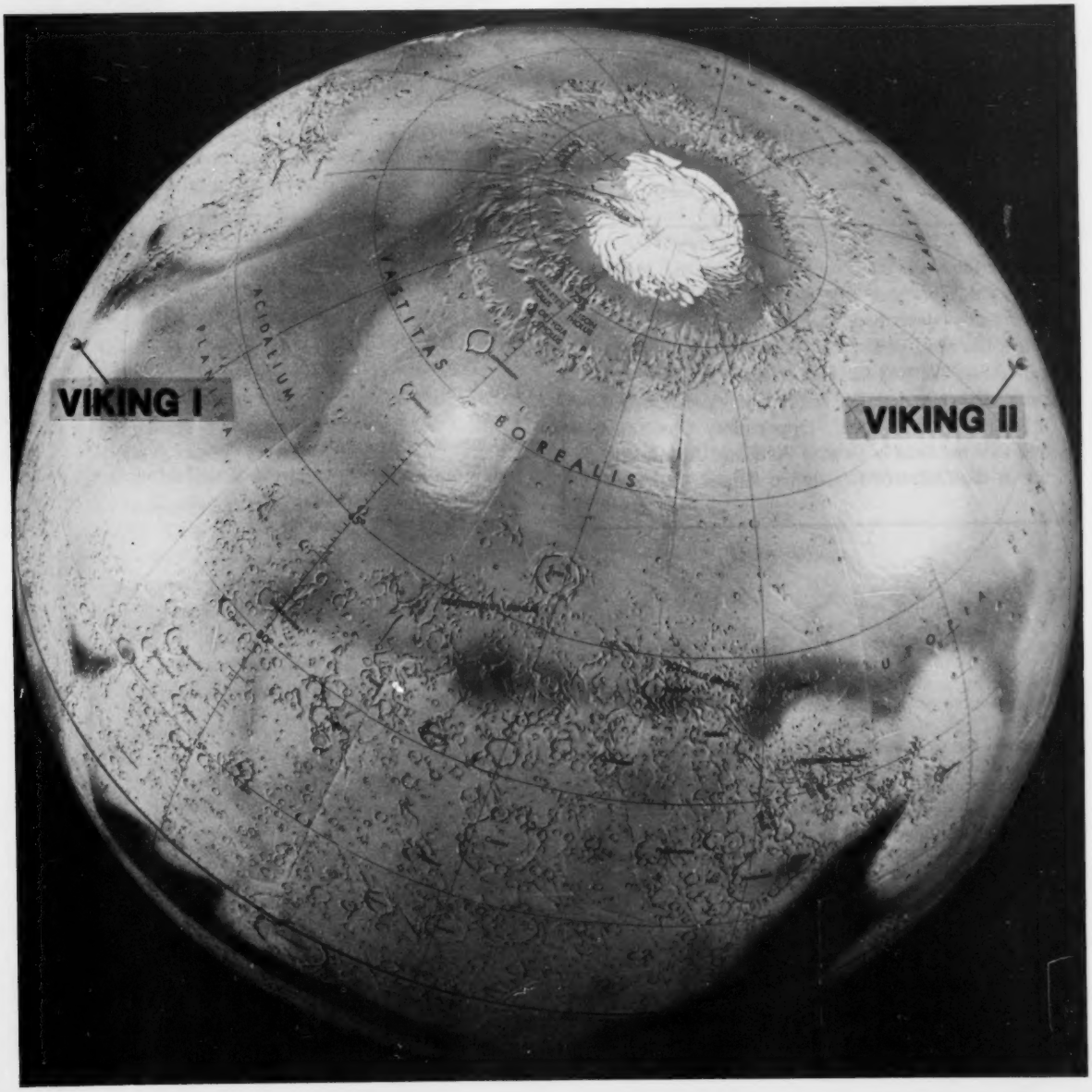

## Cover

**Mars in Perspective**—A Mars globe, positioned as though the viewer were looking down on the north polar region, shows the landing sites of the Viking 1 and 2 landers. The two vehicles are about opposite each other some 7,500 kilometers (4,600 miles) apart. The coordinates are Viking 1, 22.46 N. by 48.01 W.; Viking 2, 47.97 N. by 225.67 W. Landing times were Viking 1, July 20, 1976 at 5:12 a.m., PDT; Viking 2, September 3, 1976 at 3:58 p.m.

**Correction**—In the November issue of NASA *Activities,* on page 10, Ruth Bates Harris was incorrectly described as the "only" woman to reach the rank of Deputy Assistant Administrator of NASA. She was the *first* woman to achieve that rank. Dr. Harriett G. Jenkins is Assistant Administrator for Equal Opportunity Programs; Judith Ann Cole is Deputy Assistant Administrator in the Office of Legislative Affairs.

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# Letter from Washington

Dear Colleagues:

In this joyous time of year I extend season's greetings to all in the NASA community. We have had a year of remarkable accomplishments to celebrate and the prospect of many more to come. The Viking project teams performed flawlessly last summer, placing two landers on the Martian surface without mishap. So far as we know, we have not encountered life as we understand it at the two Viking locations, but this does not preclude the possibility of some form of existence on our sister planet.

Apart from the search for life, we have gained a fountain of information, both about Mars and the course Earth might be taking. The preservation of humankind could depend on the things we learn on Mars.

In September, rollout of the first Shuttle orbiter heralded the impending presence of man in space on a permanent basis. With the Space Transportation System, the next decade will see a widening knowledge of both Earth and the planetary system. We shall have the capacity to explore the nature of the universe; the life cycle of the Sun, the supreme ruler of our galaxy; and the evolution of the solar system. Beyond lies a better understanding of the origins and future of life.

We should not forget the constant activities of Earth resources, communications and applications satellites as well as our advances in aeronautics and in fields of "pure" science.

The Act that created our agency, and its motivation since, has been for the betterment of life on Earth. There is an important balance between what science and technology can accomplish on the one hand and the needs of society on the other. Applied sciences, inventions and technical innovations are not the end of the world's troubles; the root of improvement and progress is *how* they are used. Therefore, application of our expertise should always be tempered by our thoughtful study.

Within the last 20 years, NASA has not performed miracles, but has utilized the full extension and capability of the human mind. The way lies open to much more.

As we look into the future, it is my hope that you will all experience the fullest blessing of the holiday. season.

Sincerely,

James C. Fletcher

JAMES C. FLETCHER

# Monthly NASA Highlights

## Viking

Mars continues to reveal a great deal of information on its origin and past history. The theory of life on Mars, however, remains just that—a theory.

Thus far, organic compounds, without which life on Earth cannot exist, have not been detected at either landing location. There is the possibility that life does exist on Mars, but that (1) the Viking spacecraft have landed in the wrong place, (2) organic compounds exist but are below the detection level of Viking instruments, or (3) Mars life is fundamentally different from Earth life in the most basic way.

Although Viking's search for life has been somewhat of a disappointment, the remainder of the mission has not. Viking will produce enough raw information to keep scientists busy for years.

## NASA Receives Bicentennial Gift

The State Department notified NASA that it is the recipient of a Bicentennial gift to the United States from the Argentine government. The gift is a 2 x 8 meter (7 x 26 foot) painting depicting a view of space from the lunar surface. The painting will be temporarily displayed in the lobby of Federal Office Building 6 at 400 Maryland Avenue, S.W., Washington, D.C. Later it will be placed on permanent display at the Johnson Space Center.

## Bicentennial Space Symposium

"New Themes for Space: Mankind's Future Needs and Aspirations" was the theme of the Bicentennial Space Symposium jointly sponsored by the American Astronautical Society and the American Institute of Aeronautics and Astronautics. The symposium was held in cooperation with the National Air and Space Museum, Oct. 6 to 8. Dr. William C. Schneider, Deputy Associate Administrator for Space Flight, was the general chairman of the symposium. Individual sessions were chaired by Dr. Noel W. Hinners, Associate Administrator for Space Science; Russell L. Schweickart, Assistant for Payload Operations; and by representatives from other government agencies and private industry.

The three-day symposium reviewed man's past accomplishments in space as a basis for an advanced look at future space programs. Space programs of the past and future were related to the needs of man in the total sense of the Universe. Emphasis was given to future space program requirements in terms of the environment of Earth as a member of the Universe, and the environment of man on Earth as it influences his daily activities.

## International Astronautical Federation Congress

Dr. Fletcher was the keynote speaker for the opening ceremonies at the 27th Congress of the IAF on Oct. 11, 1976, in Anaheim, Calif. The IAF is an international, non-governmental, interdisciplinary federation of societies devoted to fostering the exploration of space through space science and the development of space technology and space law. The American Institute of Aeronautics and Astronautics (AIAA) is the U.S. member society and was the sponsoring body for the 27th Congress.

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## A Backward Glance

*Editor's Note: The following article is reprinted from the Oct. 1 issue of the Kennedy Space Center's "Spaceport News."*

She speaks of Orsino and old fishing spots called Pepper Creek and Buzzard Hammock. Scrub jays were special friends and she once raised 13 bushels of eggplant in a small garden and could not even give them away. She "liked the land with its 'coons, possums and rabbits. It was God's land."

Mrs. Leola Malone and her husband Harry were original homesteaders on parts of the land on which KSC's Launch Complex 39 stands, on Merritt Island. It is difficult to locate the exact boundaries of her original 160-acre tract, for, with the removal of the old buildings and landmarks, Leola Malone, aged 75, is now disoriented and confused. The way "they did the roads" has resulted in a loss of perspective for the elderly woman.

Born in Sparks, Ga., and raised in Miami, Fla., Leola met and married Harry Malone when she was 18. Soon after, in 1924, they moved to their 160 acres now contained within KSC. The Malones obtained the land through homesteading, a process of acquiring land from the government by fulfilling specific provisions and stipulations for settlement. Their requirements involved the cultivation of eight acres within a two-year period. She planted vegetable gardens, coleuses and periwinkles.

Being a hardy and determined woman was advantageous to Leola, for Harry was an ill man. He was constantly plagued with an undetermined illness which required a large amount of rest. He did what he could, but he could only do so much. The rest was left for Leola.

For their livelihood, the homesteaders started a poultry farm with 4,500 chickens. They would receive 500 chickens twice a month from a private company and

**One of the Originals**—Leola Malone was one of the original homesteaders in the Kennedy Space Center area in the 1920s. Now a resident of Cocoa, Fla., Mrs. Malone recently toured the NASA facility. Viewing the Saturn 5, she said "I'm so glad that I got to see it."

then Leola, single-handedly, would butcher, pluck and dress 150 chickens twice a week to sell in the community.

Traveling to the Cocoa and Titusville areas was no easy task in those days. At the time, the Tropical Trail was the only road in the area, and it was sand. A Model-T was the form of transportation used and when it got stuck in the sand, which it frequently did, Leola was hours in clearing a hard path with palmetto fronds.

What in the world ever brought them here to live in the midst of palmetto scrubs, thickets and rattlesnakes? Harry's family had homesteaded here previously and his parents and sister each owned 160 acres adjacent to the property, so Harry and Leola moved. They were the last of the Malones to homestead in the area and the last to sell their property.

On her visit to KSC, she remembered only the good things of the past and was impressed with the reality of the present and the promise of the future in the forms of the modernistic VAB (Vehicle Assembly Building) and the plans for the Space Shuttle vehicles.

She is enthusiastic about the space program, but the past still creeps in, "It's exciting, but not as exciting to me as to you. My interests are different. I liked it better when it was woodsy. It was the kind of life I liked."

After two unbearably hard years, and with Harry's condition worsening (he had been flat on his back for the last eight years), the Malones decided to sell. In 1951, they sold their 160 acres for $40 an acre and considered themselves fortunate to get that for the scrub land.

Qualifying for a farmer's loan, they bought a three-acre plot on Burnett Road in Cocoa and built a house. Leola obtained a nursery license and with her manipulative green thumb, started, produced and sold a variety of beautiful plants and flowers. "Begonia's my middle name," she says.

Their poultry business continued with Leola selling eggs until 1965 in the Cocoa area. She also became a favorite of many KCS families when it came to babysitting. Aside from her various employments, her preoccupation, however, was always with Harry.

Harry's gone now. He died in April of this year and left behind a truly "good woman." With an enduring, remarkable spirit, she once fended for them both and now fends for herself.

---

**Jet Aircraft Simulates Shuttle Orbiter**—The second of two Space Shuttle training aircraft, built by the Grumman American Aviation company, is photographed in flight over the Johnson Flight Center. Modified from Gulfstream II jets, the craft will be used to train crews for the Shuttle orbiter descent and landing profile. Cockpit interiors have followed the orbiter cockpit layout, and aerodynamic modifications provide motion and visual cues and handling qualities similar to those of the orbiter. Jutting down beneath the aircraft's wing roots are the side-force control surfaces used to imitate Shuttle sideward motion.

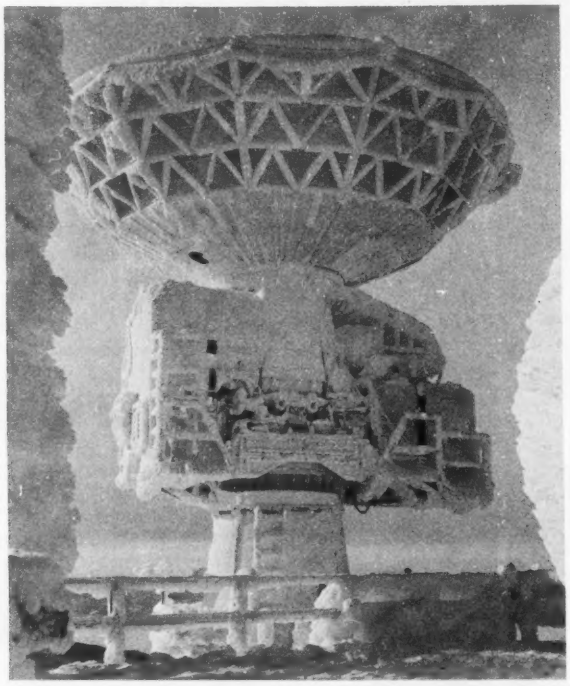
## Ely Aids Flight Programs

*Note: This is the concluding article on NASA's Ely Tracking Station, taken from the Dryden Flight Research Center's NASA X-Press.*

The Ely Tracking Station is an integral part of the Dryden center's Aerodynamic Test Range. It provides radar data, telemetry reception and communications over a large portion of the flight path used for most of the center's high-altitude supersonic flights.

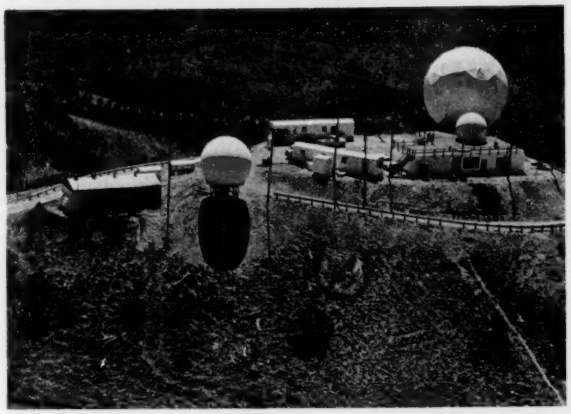
The entire operation at Ely is coordinated from a control console which gives the status of the various systems and includes a plot board that shows the location of the aircraft under observation. The coordination of the operation is done by the site manager and a technical advisor who are in close communication with the range systems coordinator in the control room at the center.

Except for the microwave data link which is maintained by the Air Force, the operation and maintenance of the Ely Tracking Station is contracted out to the RCA Service Company. Because the station is so isolated, the 13 employees who work there have to perform many duties besides operating the tracking station. It is up to them to handle facilities maintenance, which ranges from working on the access road to installing new air conditioning units and even to sealing the domes covering the antennas.



**Frostbitten Tracking Station**—Conditions at Ely can become glacial. This picture of the dome was taken before a protective covering was installed. One year, because of the weight of the ice, the dome actually toppled off.

The Ely site is currently involved in atmospheric refraction and multipath studies to provide improved tracking data. A remotely controlled radar beacon and telemetry weather facility have been placed on top of Mt. Irish which is located between Ely and Las Vegas. Mount Irish, in conjunction with Ely, provides the longest zero-degree, fixed-target path presently available for the studies. Much research has been expended to obtain refraction error models, but the accuracy of most models is questionable below 10 degrees because of lack of low-angle data. The results of this program are expected to enable the accuracy for refraction modeling below 10 degrees of elevation to be increased by several magnitudes.



**Site for Tracking Supersonic Flight**—The Ely site features a remote control radar beacon and telemetry weather facilities on a 2,800-meter-high mountain on a flight path used by most high-altitude supersonic flights.

The Ely Tracking Station is presently providing extensive support to the center's YF-12 program and to the Air Force's B-1 bomber program. The two programs are expected to be flying into the 1980's.

The site also supports various satellite programs. Preliminary reports from the GEOS program indicate that the Ely radar is the most accurate "C" band radar in the world. In fiscal year 1975, the Ely station provided support for 64 satellite missions.

Future flight research programs in various planning stages that would use the Ely facility include a hypersonic vehicle program, an advanced tanker program, two cruise missile programs, the AMST program, some tactical Air Force missions and inertial navigation system evaluations for various aircraft.

## Lava Flows May Exist on Venus' Surface

Three planetary scientists have obtained the first detailed pictures of a large portion of the surface of Venus through use of a new radar system provided by NASA. Scanning was by an S-band system installed at Puerto Rico's Arecibo radar observatory, under a $3 million contract from the space agency. Beginning in 1975, NASA also contributed support of $300,000 per year to the Venus investigation by radar planetary astronomy.

New radar imagery has revealed what may be, by Earth standards, an enormous lava flow measuring about 179,000 kilometers or 69,000 square miles; a basin resembling the large impact basins or "maria" of the Moon; and ridges perhaps created by mountain-building activities similar to those that shaped parts of the Earth.

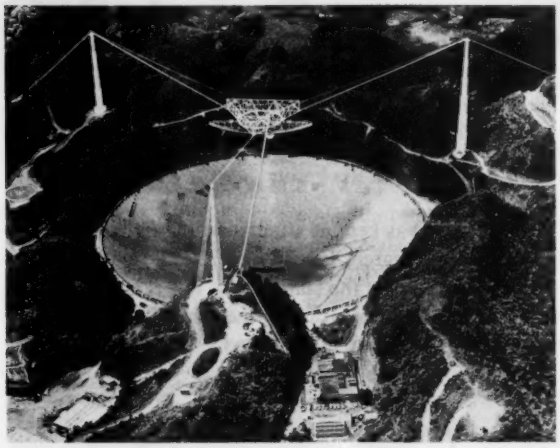
The pictures, which suggest that tectonic processes at work on the Earth and the Moon also are acting on Venus, were made at the Arecibo observatory of the National Astronomy and Ionosphere Center, which is operated by Cornell University under sponsorship of the National Science Foundation. The NASA-provided radar system affords sensitivity 50 times greater than the radar equipment previously used to observe Venus.

Scientists D. B. Campbell and R. B. Dyce of the NAIC staff, and G. H. Pennengill of the Mass. Institute of Technology reported their findings in the Sept. 17 issue of *Science*, the journal of the American Association for the Advancement of Science.

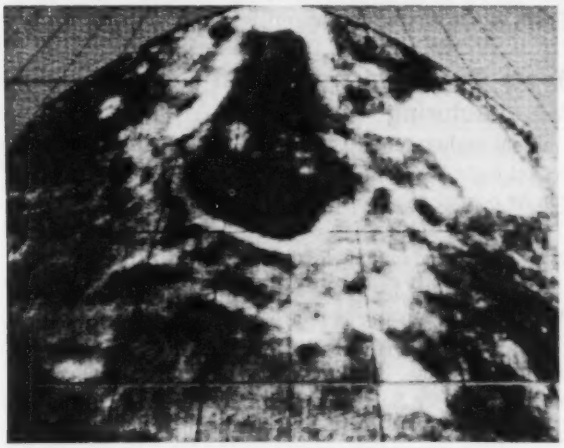
The pictures were constructed from radar echoes of the signal obtained via a high-powered transmitter operating at a wavelength of 12.6 centimeters. The time of arrival of the echoes, their strength and their precise frequency were measured with the 330-meter (1,000-foot) radio telescope of the Arecibo observatory and the auxiliary 30-m (100-ft.) telescope located some 6½ miles away.

The system creates an interferometer that permits detailed definition of areas to be mapped, and provides data that pinpoint the location of the echoing regions.

The Arecibo "big-dish" radar was able to "see" through the completely cloud-covered surface of Venus, producing high-quality images with a clarity approaching that of optical photographs of the Moon taken from the Earth. (Optical telescopes cannot penetrate the dense cloud-cover of Venus.) Data for the pictures were collected during a series of daily two-hour observing sessions in the months before and after the closest approach of Venus to Earth in late August of 1975.



**Eavesdropping on Faraway Places**—The 300-meter (1,000-foot)-diameter radio/radar antenna of the Arecibo Observatory of the National Astronomy and Ionosphere Center, is a national research center operated by Cornell University under contract with the National Science Foundation. The spherical reflector was recently resurfaced. The system can be used to observe radio and radar signals with wavelengths as short as six centimeters. NASA funded the addition of a high-power, short-wavelength radar system to the observatory, enabling scientists to study objects in the solar system as far away as the planet Saturn.



**Venusian Landscape**—The first detailed pictures of a large portion of the surface of Venus. NASA-supported studies at Puerto Rico's Arecibo radar observatory were responsible for the imagery, which scientists say may be the result of lava flows.

The pictures encompass a region of the planet from 46 to 75 degrees North latitude and extending 80 degrees in longitude—or an area of about 10.25 million square km (4 million square miles). Visible are Venusian features ranging down to only 19 km (12 mi.).

Within the broad region of study, the radar picked up two major features: a large basin extending about 1,600 km (1,000 mi.) from north to south and 960 km (600 mi.) from east to west, and a very bright region detected earlier and tentatively named Maxwell.

The basin—about the size of Hudson's Bay, covering perhaps half a million square miles—is bounded on the north, south and northwest by bright rims that seem to be a series of sharp ridges several hundred miles long. To the south of the basin lies a region of greater brightness that resembles the ejecta blankets (regions covered with debris thrown out when large objects such as meteors hit a planetary surface) seen around some craters of the Moon. The presence of ejecta blankets suggests that the Venusian basin may have been formed by the same kinds of events that created the Moon's maria. Two smaller impact craters also may be present in the Venusian basin.

The bright reflecting area of Maxwell—about the size of Oklahoma—seems to overlay an older surface and does not display the shape normally considered to be created by the impact of a meteor. Instead it may be the result of processes internal to Venus, perhaps indicative of a large eruption of lava. Maxwell's surface, which appears irregular and rough in the radar pictures, apparently contains long parallel ridges extending for hundreds of miles. These, like the basin rims, appear to be the result of tectonic or mountain-building activity. No comparable features are seen on either the Earth or the Moon, the scientists said.

## Tests Boost Confidence in Space Manufacturing

Final evaluation of pictures and data from a sounding rocket flight has reinforced the belief that better materials can be produced in space than on the Earth.

It also allayed fears by some scientists that removing gravity from the manufacturing process would open the door to other problems that could not be solved, thus making space processing impractical.

The data and amazingly informative pictures were produced by the "Dendrite Remelting" experiment, one of nine flown on Space Processing Applications Rocket-1 (SPAR-1), which was launched from the White Sands Missile Range Dec. 11, 1975.

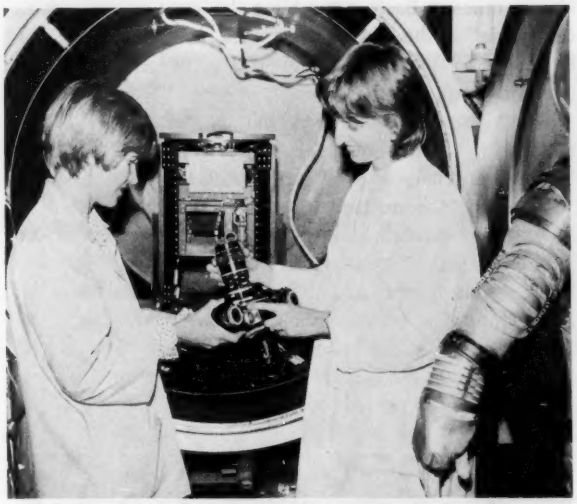
Co-investigators for the experiment were Dr. Mary Helen Johnson and Carolyn Griner, two scientists at NASA's Marshall Space Flight Center, Huntsville, Ala.

The SPAR-1 payload reached an altitude of 225 kilometers (140 miles) during the low-G portion of the flight. The scientific payload was virtually weightless for about five minutes during the mission. Slowed by a parachute system as it approached the ground, the experiment package was recovered intact and returned to the experimenters for analysis.

Scientists have known for some time that better materials could be produced by controlling the degree of homogeneity of the elements during crystallization, keeping elements mixed as desired while molten metal cools and becomes a solid.

Fluid flow determines the homogeneity. Johnson and Griner believed that gravity was the greatest cause of fluid flow. Many other scientists had theorized that other factors might be dominant in causing fluid flow, factors such as surface tension and shrinkage created when a liquid turns to a solid.

The two experimenters put about four cubic centimeters of ammonium chloride in water into a tiny transparent vial with temperature monitoring devices attached. The vial was mounted a few inches from a 35-mm. camera fitted with an oversize roll of film and equipped for automatic film advancement and timed shutter releases.



**Ready to Test Experiment**—Dr. Mary Helen Johnson (left) and Carolyn Griner install a still-sequence camera into a vacuum chamber in preparation for ground-based testing of the experiment on dendrite remelting, flown aboard a SPAR to study materials processing in low gravity.

The sample was kept at a temperature higher than 22 degrees C. (72 degrees F.) to keep it liquid until it became weightless at the start of free fall. The thermal equipment then began reducing the sample's temperature, causing it to solidify. The camera snapped 240 pictures of the process, one each second.

"We were amazed at how clear-cut the results were. One look was all we needed to see that in the absence of gravity no fluid motion was evident," Johnston said.

In the same experiment conducted on Earth, the dendrites (growths that form as material crystallizes) moved, broke off and settled to the bottom of the vial. The pictures showed that the dendrites did not move, break or settle on the rocket experiment. This maintained uniform freezing as the liquid turned to a solid.

The experimenters said it was the first time scientists had been able to "watch" the process of solidification under weightless conditions.

"Heretofore, it has been after-the-fact observation," Johnston said. "We knew what the sample looked like before and what it looked like after a flight. What happened to it during crystallization was a matter of speculation and theorizing."

Griner said the goal is to be able to control the crystalline structure of materials. In zero gravity, she said, the heavier elements of a mixture do not "settle out," but mix evenly with lighter elements.

"Control would enable us to make a material uniformly strong, stronger at one end than the other, stronger in one direction—or any way we wish, to meet a specific need," Griner said.

SPAR-1 was the first of a scheduled five-year-long series of about 15 such flights in a project managed by the Marshall center. SPAR-2 was flown May 17 and SPAR-3 is scheduled in November.

## Important Awards to JSC Personnel

During October, Johnson's director Dr. Christopher C. Kraft, Jr., was awarded the Insignia of the Knight of the Legion of Honor, the highest award the French government can bestow on a citizen of another country; Dr. Robert R. Gilruth was inducted into the International Space Hall of Fame; and Astronaut Donald K. Slayton was presented with the 1976 Heart of the Year Award by the American Heart Association.

Kraft's award, presented at the French Embassy in Washington, D.C., was given in recognition of his role in the space program and his "tireless efforts toward better understanding and cooperation between the people of the United States and France."

Kraft also was chosen in November to receive the Career Service Award given annually by the National Civil Service League "for excellence in public service."

Gilruth, former director of the Manned Spacecraft Center until 1972, and now a consultant to NASA's Administrator, was honored at a special session of the International Academy of Astronautics which convened at Alamogordo, N.M., in conjunction with the dedication of the International Space Hall of Fame at that city. Of the 35 individuals inducted into the new organization, nine were Russian, eight American and eight German.

Slayton's award was given at a ceremony at the Johnson center. He was saluted "for inspiring millions of Americans with his zeal and perseverance in overcoming a heart problem that had grounded him for 10 years, enabling him to resume his distinguished participation in America's space program." Slayton was pilot of the Apollo docking module in the Apollo Soyuz Test Project.

## New Chief for University Affairs

Dr. James R. Lawson became NASA's Director of University Affairs Nov. 8, 1976. Previously he served as special assistant to the director of the Office of University Programs, Energy Research and Development Administration. In his new post, Lawson will serve as principal adviser on NASA's relations with universities and provide management of NASA activities involving universities.

Lawson, a native Kentuckian, received his BA degree in physics from Fisk University and his MS and Ph.D. in physics from the University of Michigan. Before coming to NASA, he served as an educator and administrator in various colleges. As chairman of the physics department at Fisk University, he was involved in research of infrared spectroscopy. He became vice president of Fisk in 1966 and was president of the university from 1967 to 1975.

Lawson's awards and honors include the Rosenwald Fellowship. He is listed in *Who's Who in America, American Men of Science*, and *The 1,000 Most Influential Black Men*. He is a member of Phi Beta Kappa and Sigma Xi and a recipient of the Afro-American National Fellowship Award.

**Award for Division Accomplishments**—Ray Kline, NASA's Assistant Administrator for Institutional Management, hands a $2,500 Group Achievement Award to Peter L. Robinson, Jr., director of the graphics and management presentations division. The award recognized the high standards maintained in the unit, following the merger of the three headquarters graphics operations. From left to right: Larry Lindsey, Jane Behney, Dorothy Eubank, Al Cole, Frank Steward, Ellsworth Simmons, Al Jordan, Robinson, Linwood Walls, Hilliard Dean, Kline and Dale Eno. Not shown are Dave Snyder, Mary Lou Cowley, Bill Hayden, Carl Burrell, Larry Welch and Inez Williams.

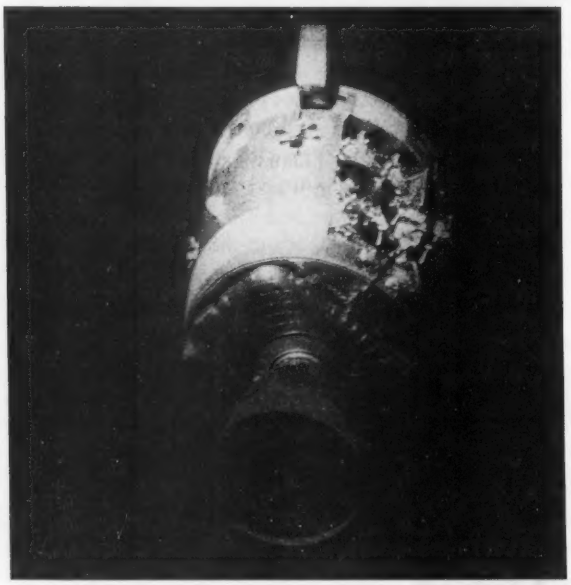
## Prospectus

*Survival in Space*

As spacecraft and space-related projects proliferated in the early years of NASA's existence, a particular state of mind—and attitude—became an almost palpable characteristic among NASA executives and program managers. This was the "What happens if . . .?" syndrome, and it became an integral part of the agency's approach to the many projects and experiments on NASA's agenda.

Before manned missions were launched, the possibilities for mishap and failure had been countered with component back-up systems and a meticulous list of contingencies. Ground control had to be flawless, ready to cope with any eventuality involving the dispatch of men to regions a quarter of a million miles from Earth. "What happens if . . .?" sessions were frequent and prolonged.

All the conclusions and solutions were put on tape and carefully stored away, on standby for instant retrieval. As a result, the astronauts carried into space not only their remarkable courage, but also confidence. From the moment of launch and beyond, they knew that almost every possible anomaly had been anticipated and planned for.



**Imperiled Spacecraft**—This view of the severely damaged Apollo 13 service module was photographed from the lunar module/command module after the two vehicles had separated. As seen here, an entire panel on the spacecraft was blown away by the explosion of an oxygen tank. The severe damage made it necessary for the space travelers to abandon the service module and use the lunar module as a "lifeboat."

In the steady march toward the Moon throughout the Mercury and Gemini missions, not a man had been lost in space, although several astronauts *were* lost in crashes of conventional jet aircraft. By early 1967, the culminating Apollo program was in readiness for its first manned flight in Earth orbit. Then came the terrible tragedy of Virgil I. Grissom, Edward H. White II and Roger B. Chaffee, which brought about agonizing reappraisals and the realization that the "What happens if . . .?" approach had to be intensified. The dreadful flash fire that took three men's lives served to underscore the chilling fact that, despite all the careful planning, a crucial problem had been overlooked: the combustibility of materials in a pure oxygen environment at sea-level pressure.

As we know, the Apollo program was halted for almost two years, but planning for future missions was not. NASA personnel redoubled their efforts to anticipate and reach solutions to all kinds of potential dangers, on the ground and in outer space.

In 1968, that awful year of political assassinations and cities afire, Apollo began its resurgence. One by one, the test flights succeeded. Earth orbit flights were followed by lunar orbit when the crew of Apollo 8 read biblical verses from Genesis on Christmas Eve. A national time of disaster waned with the heartening potential of a lunar landing before the mandated end of the decade.

It all came together in 1969 when Apollos 9 and 10 demonstrated the complete feasibility of placing a spacecraft, manned by human beings, on the Moon. The dress rehearsals were almost flawless. Now, said the commander of Apollo 11, "It was time for us to give our best." Neil A. Armstrong carried out his pledge on the afternoon of July 20, the historic moment when he stepped onto the lunar surface. For the entire world, Apollo 11 was an event so exhilarating, so staggering in import that many people could not believe it. Men had gone to another world, explored it and returned without mishap.

Apollo 12 followed, an extension of the initial Moon landing and, to some, it was an anticlimax. The initial breakthrough had been made and lunar landings were now accepted in public consciousness as readily as immunization for polio. Apollo 13, in April of 1970, was to be just another repeat performance. It wasn't, however. Before it was over, the "What happens if . . .?" approach was put to the ultimate test.

James A. Lovell, Jr., the commander, had already logged 572 hours in space. John L. Swigert, Jr. and Fred W. Haise, Jr. were conscientious later additions to the astronaut corps. The launch, on April 11, promised a widening knowledge of the Moon's properties and their relation to Earth.

Two days into the flight, 200,000 miles from Earth, the crew said good-night to Mission Control and prepared to sleep. Some 10 minutes later, Swigert sent a laconic transmission: "Houston, we've had a problem here." It was the understatement of that and many another year. Oxygen tank No. 2 had blown up, causing No. 1 tank to fail also. Warning lights showed the spacecraft had lost two of its three fuel cells. The lunar landing was off. The emergency of getting three men back to Earth was on.

**Suspenseful Moments**—Fear and worry pervaded the mission operations control room at the Mission Control Center during the final 24 hours of the problem-plagued Apollo 13 mission. Here, flight controllers and NASA officials confer at the flight director's console. At the time, the Apollo 13 moon landing had been cancelled and the crewmen were in transearth trajectory, attempting to bring their crippled spacecraft home.

With oxygen venting quickly from the command module, the crew and Mission Control rapidly came to the conclusion that a return would have to be made in the lunar module, the vehicle that was supposed to settle on the Moon. That solution had been discussed and thought out six years before, but ground support would have to supply innovations in a hurry. The crew floated into the LM and ground personnel worked out a procedure for the transfer of battery power. Water had to be conserved for the return; the LM was built to support two men for two days; now, it would have to sustain three men for four days.

Mission Control worked frantically to devise a way to hold down the rise of carbon dioxide from materials on board. Five hours after the explosion, they computed a 35-second fuel burn that changed a lunar landing course to a free return course. Swigert and Haise were calmly photographing the Moon as the transition took place. Debris from the failed service module was impeding navigation but Houston was ready with a solution—check the spacecraft alignment with the Sun. The ground flight directors had considered that situation years before.

Apollo 13 began its descent. With electrical systems off, it was a trip both cold and wet. And Mission Control was quickly developing procedures for powering the still attached Command Module before reentry. The program people drew up the necessary innovations in three days, a process that normally would have taken three months. Unknown to the astronauts, millions of people on Earth were praying for their deliverance. The world press

**Finale to Apollo 13**—The U.S. Navy helicopter 66 hovers over the Apollo 13 spacecraft as it picks up rescue swimmers of the Underwater Demolition team. Apollo 13 astronauts were aboard the USS *Iwo Jima*, in background. Later the spacecraft was retrieved and taken aboard the carrier.

## Prospectus

*Continued*

contained little else but the perilous homeward voyage of three men who had faced disaster 200,000 miles into the heavens. Three hours before splashdown in the Pacific, the LM separated from the module, its work done. And the landing, near the carrier *Iwo Jima,* was almost perfect.

NASA records the flight of Apollo 13 as a failure. But the fact that the three-man crew is alive today can be attributed to their excellent training and their instinctive, courageously correct reaction to a grim accident, abetted by ground-support ingenuity born of years of thought and devotion. In that instance and others, it was always time for us to give our best. It was given.

**The Perilous Journey Ends**—A water-level view of the Apollo 13 recovery operations in the South Pacific. The photo shows astronauts James A. Lovell, Jr. (center) and John L. Swigert, Jr. (left) as they awaited the return of the rescue helicopter which had transported lunar module pilot Fred W. Haise, Jr. to safety. The third man is a member of the Navy's underwater team that assisted in the recovery of the three astronauts.

## Special Achievements Recognized

Two NASA-related individuals were honored Nov. 16 at ceremonies held at the Smithsonian Institution Museum of Natural History auditorium when Charles F. Hall and Michael Collins were given Special Achievement awards by the National Civil Service League. Such awards are given to mark exceptional contributions that bring credit to a federal agency and to public service.

Hall is project manager for NASA's Pioneer project. His personal involvement in every aspect of the program has established a philosophy which led to the success of the mission. The success of the project can be attributed in great part to his extraordinary skill and performance.

Collins, the third man to walk in space, presently is director of the recently completed National Air and Space Museum of the Smithsonian Institution. He served as command module pilot during NASA's Apollo 11 flight, the first trip to the Moon by earthlings. His award honored him for his efficiency, inspiration and creativity in setting guidelines for operation of the museum.

**Big Money Saved**—Johnson Space Center director Dr. Christopher C. Kraft Jr. (left), presents Minutemen cost reduction trophies to three men who saved NASA almost $23.1 million, by proposing reductions in Space Shuttle ground support equipment. The three—from right to left—are the reliability division's Joseph H. Levine, Henry L. Williams and Marion E. Merrell.

## "What Color is a Man?"—A Poem

*The following poem, written by Roslyn Monroe, 25, the daughter of Roscoe Monroe, a member of the Office of Equal Opportunity Programs, was dedicated to Ruth Bates Harris by NASA's OEOP during an open-house ceremony saluting Harris last Oct. 14.*

What Color is a Man?
Is He Black?
As the skies of night
As dark as darkest ebony;
With features strong and bold
That cause him to hide in shame
When others shun his name?

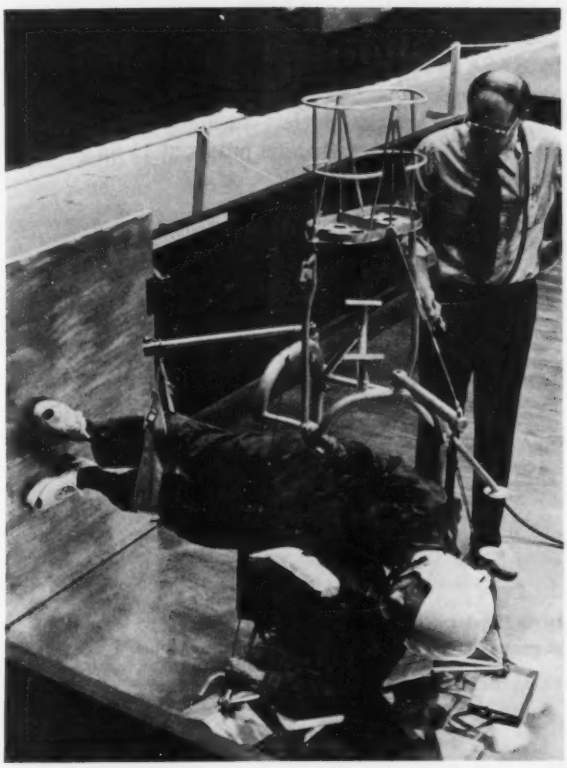
What Color is a Man?
Is He Red?
As rain-soaked clay
As bright as paint of war
With features keen and sharp,
Whose eagle eyes scan a nation
That bind him to a reservation?

What Color is a Man?
Is He Yellow?
As China suns
As golden as its past
With features small and sleek,
Whose life in this Eastern land
Is smothered by an Emperor's hand?

What Color is a Man?
Is He White?
As Alpine snow
As light as Cheshire cream
With features straight and fine
That struggle against himself and others
And cloud the hope of being brothers?

What Color is a Man?
A man is flesh
As God in Christ
As colorless as love
With features undefined
No matter what his creed or land
Bind all together
MAN to MAN

**Farewell Party**—Dr. James C. Fletcher (left) and Assistant Administrator for Public Affairs Robert A. Newman present a NASA memento to departing Ruth Bates Harris. NASA headquarters employees bade Harris goodbye on Oct. 15, 1976.



**Hungover**—At the Johnson Space Center, engineer Darrell Arndt hangs from a floating air-bearing frame as he demonstrates suction cups on a pair of sneakers. The cups may be used on the shoes of Shuttle orbiter crews. Standing by is instructor W. P. Henry.

*This is the fourth in a series of profiles of NASA field centers.*

## Michoud Assembly Facility New Orleans, Louisiana

More than 3,800 people are at work at the Marshall Space Flight Center's Michoud Assembly Facility, making the rafters once again ring with the sounds of tools on metal and the noises of equipment and people—the way it was years ago when about 12,500 were helping to build Saturn boosters.

The main effort underway now is fabrication of the external tank for the Space Shuttle. Martin Marietta Aerospace has been installing giant fixtures and tooling for the mammoth task for more than a year, and production capability is close at hand.

Michoud has other tenants. Use by other government agencies has been increasing steadily over the past several years, as facilities no longer used for NASA programs were leased out.

The Michoud facility is on a triangular tract of 364 hectares (900 acres), some 24 kilometers (15 miles) from downtown New Orleans. The entire complex is within New Orleans city limits.

The Government-owned facility was selected in 1961 by NASA as the manufacturing site for Saturn 1B and Saturn 5 first stages. The Chrysler Corp. built 14 Saturn 1B vehicles, the last one in the mid-1960's; the Boeing Aerospace Division produced 13 Saturn 1C, the last one in the late 1960s.

**In Its Heyday**—The Michoud facility back in 1965 when it was at peak production of Saturn program components.

Employees and operations were then phased down and the center, as far as NASA activities were concerned, remained in a state of near-hiatus until 1973, when plans for building the external tanks for the Space Shuttle came off the drawing board and moved into an active status.

About 40 government employees handle the business of Michoud for the Marshall center under the direction of Robert C. Littlefield and his staff of seven managerial assistants. The group is part of the MSFC Shuttle Projects Office.

The Martin Marietta Corp. holds the contract from NASA to design, develop and manufacture external tanks for the Space Shuttle, NASA's reusable launch vehicle to be put into orbit in 1980. (Rollout of the first orbiter for the Shuttle, called *Enterprise*, took place last September in California.) Fabrication of the first test tank by 1,329 Martin Marietta workers has already begun at Michoud.

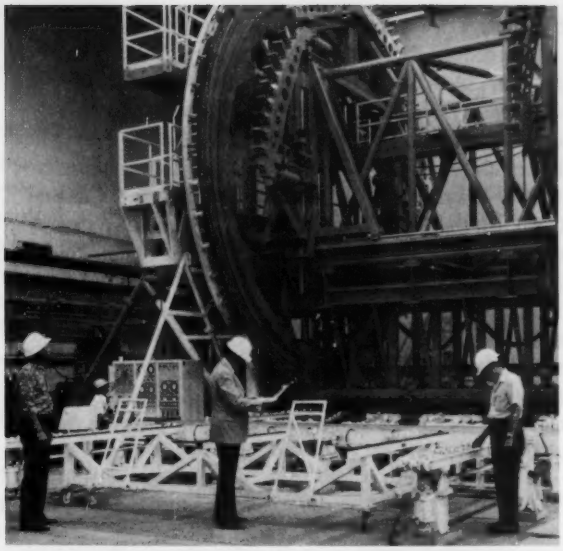
The huge, two-cell propellant tank will measure 46.9 meters (153.7 feet) in length and 8.4 meters (27.6 feet) in diameter. Empty it weighs 34,020 kilograms (75,000 pounds); loaded with liquid hydrogen and liquid oxygen to be used by the three Space Shuttle main engines, the tank will weigh 737,100 kg (1,625,000 lbs.).

Tooling fixtures set up in the manufacturing building are so massive that some visitors think Michoud is being converted to shipbuilding. One fixture, more than half the length of a football field, is to be used in joining, trimming and welding the major parts together to form the liquid hydrogen tank portion of the tank. It is believed to be the largest horizontal welding fixture in the world.

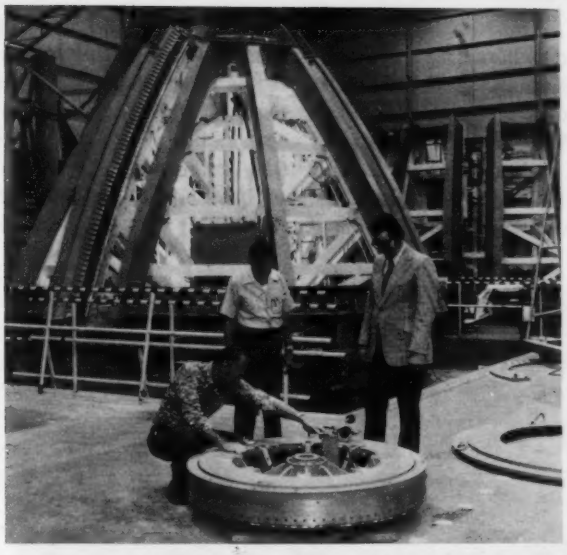
About 32 major kinds of fixtures are planned for the building, to enable the contractor eventually to reach a production output of as many as 60 of the massive external tanks in one year. At present, 28 fixtures have been completed, three are in manufacturing processes, and one has been deferred.

Tenant organizations with a total of about 2,000 employees at MAF have a wide range of important missions including complex business and computer activities of the Department of Agriculture, research and development biodynamic programs of the Naval Aerospace Medical Research Laboratory, and design, development and manufacturing programs for prototype surface effect ships by the Navy and Bell Aerospace Company.

Other tenant programs include flood control activities of the Army Corps of Engineers, manufacture of M-60 tank component parts for the Army by the Chrysler Corp., and area government audit responsibilities carried out by the Defense Contract Audit Agency.



The huge trim and weld tool for the external tank, at Michoud.



The cone-shaped structure in the background is the trim and weld tool for the external tank nose cone. Three Michoud employees are checking oxygen tank tools in foreground.

Boeing Services International was awarded a contract in January 1975, to provide support services to all NASA, contractor and tenant elements at Michoud.

Included in these support services are: transportation, fire protection, medical systems, photography, food, supply, communications, plant maintenance and repair, plant engineering, messenger and mail, refuse disposal, reproduction and utilities.

Security and custodial services at Michoud are furnished under separate contracts let to Reguard Security Service and Red Janitorial Services.

Boeing and other support contractors at Michoud employ a total of about 385 people.

By far the largest of some 14 buildings at MAF is the manufacturing building, which uses 17 hectares (43 acres) of floor space under one roof and has a floor-to-ceiling truss height of 12.2 meters (40 feet). It has two mezzanines, one running the full width (333.8 meters or 1,095 feet) of the building, as well as a cafeteria. The rear of the building, used for shipping and receiving, has a covered loading platform.

Other structures range from the vertical assembly building, which stands 65.5 m. (215 ft.) tall, to the barge dock ("Port Michoud"), which opens into the Intercoastal Waterway. The slip was transferred to NASA by the Department of the Army. An asphalt roadway extends from the west end of the original runway and onto the concrete dock, which is built on concrete pilings. An extension to the dock, completed in 1966, added two new concrete berths to the port.

Michoud's history goes back to March 10, 1763, when the governor of the French colony of Louisiana granted a 13,962-hectare (34,500-acre) tract to Gilbert Antoine de St. Maxent, soldier of the king and successful New Orleans merchant, who owned it for 31 years. It was a swampy area where cypress and muskrat were plentiful.

The land passed through several hands but was never cultivated extensively because of its watery character. It was leased for timber and muskrat-hunting privileges.

Its name came from the Michoud family which owned the tract for more than 80 years after Antoine Michoud bought it in 1827. He sold it in 1910. Two ancient sugar-house chimneys of the Michoud plantation still stand on the site.

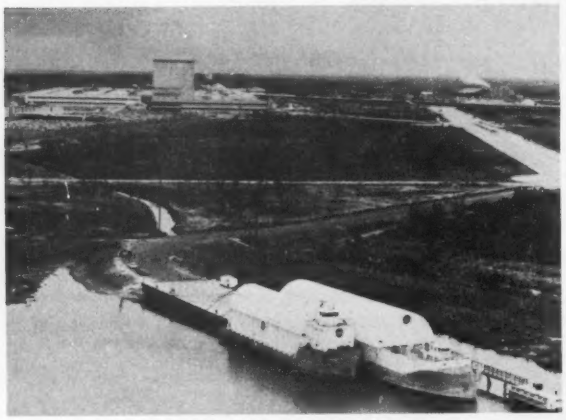
At the outbreak of World War II, the area was selected as the site for a shipyard, and a tract of the plantation was bought by the government for that purpose.

Higgins Industries got the contract to build liberty ships and the Corps of Engineers began dredging a canal from the plant site to the waterway. Considerable earth fill-in and a large number of pilings were required. The project was abandoned and the Higgins contract cancelled in 1942.

The partially-built shipyard later was taken over for building large cargo planes, but only two planes were built before war's end, and the plant was closed in 1945.

The Army Ordnance Corps selected Michoud for manufacturing tank engines at the beginning of the Korean War. In 1951, the Chrysler Corp. was awarded a contract for engines for Sherman and Patton tanks. Peak employment reached about 2,200.

The plant was closed in 1953. It remained idle until 1961 when it was selected by NASA for the production of Saturn vehicle first stages.



The barge dock at Michoud.

## Advanced NASA-Army Research Aircraft to Be Displayed

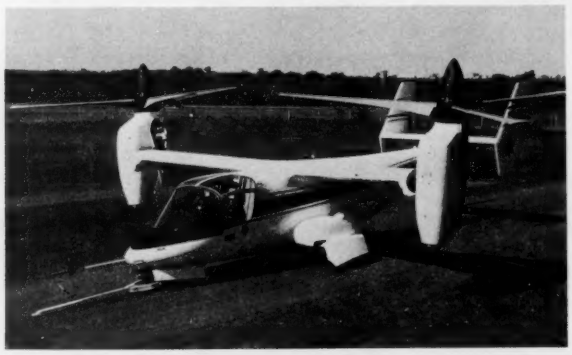
A new research aircraft that combines features of helicopters and conventional airplanes was rolled out in ceremonies Oct. 22 at the Bell Helicopter Textron flight test facility at Arlington, Texas. NASA's Ames Research Center and the Army's Air Mobility Research and Development Laboratory have scheduled a two-year flight testing program for the tilt rotor airplane. Designated the XV-15, the craft was built by the Bell company for a joint NASA-U.S. Army research program.

The XV-15, a proof-of-concept research plane, is capable of developing and demonstrating tilt rotor concept technology and assessing its potential for noise reduction, reduced takeoff and landing area requirements. The effectiveness of combining helicopter utility with the longer range and higher speed characteristic of conventional airplanes also is part of the study. If the design proves feasible, the new aircraft will be of decided benefit to military and civilian aviation.

The XV-15 design is a 42-foot-long, 32-foot wing-span aircraft incorporating wingtip mounted engines, transmissions and 25-foot prop rotors which tilt from a helicopter position for hover, vertical takeoffs and landings, to a horizontal position for forward flight. In the airplane mode, the aircraft is capable of forward speeds of more than 300 miles per hour. It is expected that the tilt rotor will operate with less noise than conventional helicopters or turboprop aircraft of comparable size.

The rollout ceremony marked a major milestone in the joint NASA-Army tilt rotor program. A number of U.S. companies have participated in the effort. Major subcontractors on the XV-15 include: Rockwell International, Tulsa Division (fuselage and empennage); AVCO-Lycoming, Stratford, Conn. (engines); Calspan Corp., Buffalo, N.Y. (automatic flight control system); and Steel Products Engineering Co., Springfield, Ohio (conversion and flap drive systems).

The first XV-15 will undergo ground and hover testing, and then be shipped to NASA's Ames Center for extensive testing in the 40- x 80-foot wind tunnel. Initial envelope expansion flight testing of the second tilt rotor craft will take place at the Bell facility in Texas in the fall of 1977.



**New Research Aircraft**—The XV-15 tilt-rotor plane was built by the Bell Helicopter Textron company and is the first of two such aircraft being produced under a NASA/Army contract. The craft combines features of both helicopters and conventional airplanes.

## Conservation of Natural Resources

NASA and the Department of the Interior recently issued a joint Memorandum of Understanding concerning the conservation of fish and wildlife on NASA installations. Among other things, the statement directs, under the Sikes Act Extension, that programs be established and maintained for the management of such resources "for the enjoyment of future generations"; that the Interior Department determine "where conservation and rehabilitation programs are most needed on NASA installations . . . and develop a comprehensive fish and wildlife plan for conservation and rehabilitation programs . . . on NASA lands."

The document states also that comprehensive plans developed be consistent with overall land use and management plans for the lands involved. The Administrator of NASA must issue approval of all actions taken under the conservation directive. Representatives of both agencies are ordered to meet annually to review progress and offer additional recommendations.

## University to Build Permanent Display of Space Photos

One of the world's largest and most comprehensive collections of lunar and planetary imagery is being compiled at the University of Arizona's Lunar and Planetary laboratory and will be partially funded by the Planetary Geology program of NASA. The site of the collection—to be known as the Space Imagery Center—will be in the UA's Gerard P. Kuiper Space Sciences Building. The center will contain nearly half a million images of planets and their satellites taken both from Earth and in space, as well as television images, topographic and geologic maps, and all the data pertaining to how and when the images were made.

According to Robert G. Strom, UA associate professor of planetary sciences and head of the facility's coordinating committee, the collection will be a unique research tool in the planetary sciences. Strom believes that one of the most progressive features of the center will be its thorough indexing of pictures according to the geologic features they depict. In addition, a computerized microfiche retrieval system will give researchers access to the images in a matter of seconds.

Gail Georgenson, who holds a Master's Degree in Library Science from the UA, has been chosen as supervisor of the center. She has been working closely with Strom since last April on matters such as future acquisitions, collection arrangement and problems related to the center's operations.

The photos range in size from standard 35mm negatives to panoramic views as long as 1,143mm (45 inches). Most of the photos already had been accumulated at UA through its years of involvement with U.S. lunar and planetary space missions, but additions to the collection will be coming from new missions, including the current Viking explorations of Mars and next year's Mariner Jupiter/Saturn probe.

The Space Imagery Center will be available for use by the UA community and scientists from other institutions in this country and abroad. The general public will be permitted to visit the center by appointment. Copies of the spacecraft imagery to be included in the center's displays are available through the National Space Science Data Center (NSSCD) at Greenbelt, Md.

## NASA Federal Women's Program Coordinators Attend OEO Meeting

The Office of Equal Opportunity Programs held its second annual FWP meeting at NASA headquarters Sept. 29 and 30. The objectives set for the meeting were: to acquaint the FWP coordinators with some of NASA's top officials as well as OEOP's division directors to determine how various roles interlock to help eliminate barriers to the employment and advancement of women; to gain a sound knowledge of how to develop and monitor affirmative action plans; to become enlightened on the factor evaluation system; to develop ideas of how the 10th Anniversary of the Federal Women's Program can be celebrated and to have each FWP coordinator present work plans for FY 1977-78 for the generation of new ideas for better programs throughout NASA.

The two-day meeting was attended by: Dr. Alan Lovelace, Deputy Administrator; Dr. Harriett Jenkins, Assistant Administrator for OEOP; Peter Chen, Deputy Assistant Administrator for OEOP; Carl Grant, director of Personnel; and Janice Mendenhall, director of the Federal Women's Program, U.S. Civil Service Commission. Other NASA personnel who made outstanding contributions to the success of the meeting were: Earl Ginyard, headquarters EO officer; Hermilo Gloria, Ronald Dall, Stanley Kelly, Will Douglas, and Alfonso Ludi, all of OEOP; Frank Sutherland, office of personnel, and Jonathan Boyd of the EO professional recruiting office. All NASA centers were represented.

**Equal Opportunities Are Discussed**—Dr. Alan Lovelace, Deputy Administrator (far right), attended his first NASA Equal Opportunity council meeting at the Lewis Research Center Sept. 22. He said that NASA has made significant EO accomplishments in the past few years of which it can be proud but, compared with other Federal agencies, much still needs to be done. He added that NASA is considered to have the best group of engineering managers and the most engineering accomplishments in the Federal government. In this picture, Harriett Jenkins stands at left. Seated, facing camera, are EO council members Ruth Klein Essink and Dr. Bernard Lubarsky. Lovelace praised the council for its insight into the existing EO problems and the goals it set and affirmed his dedication to helping the council achieve their goals.

## The Future Exploration of Mars

*Editor's Note: In this, the final installment of Dr. Carl Sagan's six-part discussion of the Viking mission, the author considers additional voyages to the Red Planet.*

There are some people who will bet on anything, gamblers by temperament, oddsmakers inveterate. Even some scientists have this gaming instinct and have been heard quoting odds on the chances of life on Mars and the prospect that Viking will find it. The odds I have heard quoted range from even to a million-to-one against. When I hear such high odds, I always lay my dollar down. It is not that I am convinced there is life on Mars, but when such high odds are offered, it seems to me the significance of a success far outweighs the uncertainty of the issue: If I win, I win big; if I lose, I lose only a little.

The same is true of the Viking mission itself. The investment represented by the Viking mission is very large by scientific standards (but very small by military standards). If Viking succeeds, it will have been a great bargain. The mission will be asking one of the epochal questions in human history: Is there life on other planets? Is biology a cosmic commonplace? Or in some strange and poignant way is life a rarity in this vast and awesome universe in which we are imbedded?

But there are many other aspects of Viking besides biology. By determining the interior structure and surface chemistry of the planet, Viking holds the promise of illuminating our knowledge of the formation and evolution of planets in general. By studying, both from lander and from orbiter, the meteorology of the planet, Viking has a significant chance of improving our knowledge of weather in general. The environment of Mars is significantly different from the environment of the Earth. Any theory which pretends to predict, much less control, weather must be able to account for the weather on Mars—a place with enormous temperature contrasts, no oceans, pronounced topographical relief, and sand and dust storms on a colossal scale. Furthermore, Viking represents the development for the first time of a planetary lander capability by the United States and the ability to perform—without returning a sample to Earth—tests for organic chemistry and biology on distant worlds.

Even though the landing sites proved to be safe and Viking worked as hoped, it is still difficult to gauge the full extent of the mission's success. We do not know yet whether there is life on Mars. If we do find evidence of life, we cannot know whether life is present over the whole planet or only in a few favorable micro-environments. After all, we are landing in only two places on Mars. If we were landing in only two places on the Earth, how likely is it that we would be able to characterize thoroughly the geology or meteorology, much less the biology, of our planet?

An amusing exercise is to imagine the tables reversed, and Viking being sent from Mars to the Earth instead of the other way around. Suppose that the (hypothetical) martians have selected four places on Earth which have the same geographical coordinates as the two prime and two back-up landing sites which we have chosen for the landings on Mars. Of course, the choice of coordinates is entirely arbitrary. The zero degree meridian on a globe of the Earth is chosen to pass through Greenwich, England only because it is in Greenwich that a royal observatory was established in a time when Britain was master of the oceans. The zero degree meridian on Mars

**Martian Ice Cap**—A feature never observed before the Viking mission is Mars' north polar ice cap, seen in this photomosaic of high-resolution pictures. The pictures, taken during October as the Viking orbiter 2 orbited for the 56th time around Mars, show a spectacular array of features caused by the uneven distribution of ice and the exposure of defrosted, layered material on slopes. The area shown extends about 360 kilometers (225 miles) from 77 degrees North, 350 degrees West, at the edge of the ice (bottom) to 83 degrees North, 330 degrees West (top). The north pole is out of view but would be about 300 kilometers (186 miles) beyond the observed terrain.

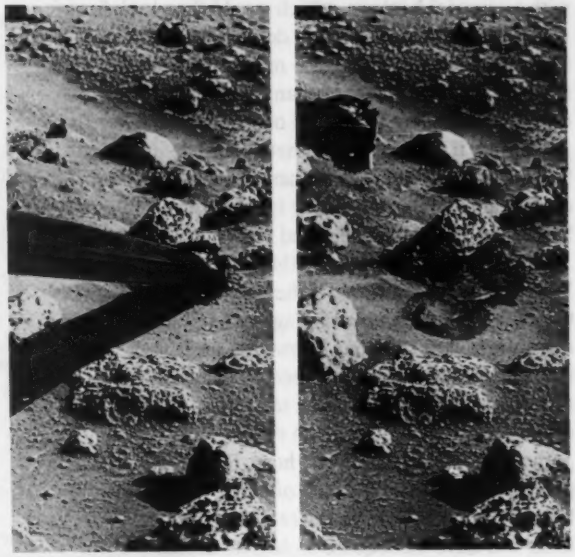
has been chosen, equally arbitrarily, by terrestrial astronomers, to pass through a prominent dark marking which we call Meridian Bay. Had we chosen a different zero degree longitude, we would deduce some other equivalent landing places on Earth.

But the exercise is interesting. If the tables were reversed, the prime landing site of the first Viking would be in the middle of the Atlantic Ocean. Since Viking is not equipped for operations in water, it would rapidly sink—blub, blub, blub—and would be considered a mysterious failure. The back-up landing site for Viking 1 would be in the Gulf of Tonkin—familiar in recent terrestrial history—and would represent another mission failure. The prime landing site of Viking 2 would be in the North Atlantic. (Three out of the four landings in water correspond well to the ratio of ocean to land on the planet Earth.) But the back-up site for Viking 2 would be not only on land, but at a dazzling place: the southwest entrance to Yellowstone National Park. If trees could be avoided during landing, the spacecraft would reap a rich harvest of scientific results: not only microorganisms but bears, rangers and tourists. Such a mission would undoubtedly be considered a success by the martians.

This is one of many reasons why Viking is not a definitive search for life on Mars, but, rather, only a significant first step. This is true on many other levels. I have had several nightmares about the Viking mission. In one of them I dream we see footprints beside the lander every morning, but we never see anyone who makes the footprints. The situation could have been remedied had Viking included a searchlight for nighttime television. But despite its high cost, Viking was severely constrained fiscally and a searchlight simply cost too much. Another nightmare I have is that a little more than three meters (10 feet) away from the lander is something astonishing—say a regular purple geometric pattern on the ground—something we would dearly love to scoop up and analyze. But the mechanical arm which retrieves such samples is only three meters long. The purple patch remains tantalizingly out of reach. Viking is not a rover. It stays put where it lands.

These examples illustrate one important future direction for successor missions to Viking. A Mars rover is of extraordinary interest not only because it greatly enhances the scientific capability of the mission, but also because it could command public attention on a day-to-day basis—a kind of cooperative, if vicarious, exploration of Mars by the American and world public.

Each day we would scan the surroundings, see what place seems of greatest interest, and then slowly roll on tractor treads to it. Is that a peculiar rock formation to the east or something else? Is that volcano active or are we seeing an afternoon cloud poised near its summit? Is that a dust cloud at the horizon or smoke? What will the ground look like when we move into quite a different geological region two weeks from now? A Viking rover could traverse many hundreds of miles during a reasonable lifetime and is, I think, a mission which could command worldwide attention and enthusiasm.



**Shoving Rocks Around on Mars**—Viking's soil sampler collector arm pushes a rock aside on the surface of Mars. The irregularly shaped rock (named "Mister Badger" by flight controllers) was pushed several inches by the arm, which displaced the rock to the left of its original position. A soil sample was taken from beneath the rock, then delivered to Viking's organic chemistry instrument for a series of analyses.

If biology is found on Mars by the Viking of 1976, the follow-on missions would, of course, be dedicated to characterizing life on Mars. What does it look like? What is its biochemistry? Is it based on the same sorts of molecules as life on Earth (where all of us—viruses, tadpoles, turnips, trees and human beings—work off two kinds of molecules called nucleic acids and proteins.) What are the similarities and differences in the evolution of life on the two planets? Is there really a much broader range of adaptations possible than we are familiar with on Earth? How does a martian work?

Eventually, whether or not we find life on Mars, we will want to return a sample of Mars to the Earth for more detailed study. There are some scientific instruments so complex, massive and expensive that it is difficult to envisage them being miniaturized and sent to Mars at any time in the foreseeable future. Returned sample missions are expensive—probably significantly more expensive than a Viking rover—but perhaps not ruinously so. However, a serious question about Mars returned samples is what is called back contamination. We do not know whether terrestrial microbes can survive and reproduce on Mars, but we consider it not impossible. It would be a ghastly error to send to Mars a spacecraft contaminated

with terrestrial bacteria, which would then look for life on Mars and succeed only in detecting its own contaminants. There are also many scientists concerned that, for possible future human utilization of Mars, we should not implant terrestrial organisms which might proliferate if the martian climate could be induced to become more clement. For these reasons Viking and comparable Soviet spacecraft intended for Mars landings have been rigorously sterilized.

But now the opposite possibility exists as well. Could Martian microorganisms, if they exist, when transplanted to Earth cause disease and plague or ecological disruptions here? No one knows the answer to that question. Some think that, because of the evolutionary differences expected between terrestrial and martian organisms, there would be no chance for Martian pathogens to gain a foothold here. But others think that, precisely because of the lack of past evolutionary contacts between organisms from the two planets, terrestrial hosts will have inadequate biological defenses against Martian pathogens. Again this is an issue where our uncertainty is large and the possible consequences immensely serious.

Some scientists hold that no unsterilized samples should be returned to Earth from Mars until we know a great deal more about Mars. Examining the sample in, for example, an orbiting space station around the Earth does not solve the problem because the scientists in the space station will eventually want to come back to Earth, and the latency period of diseases can be very long. The problem would be resolved if a foolproof method could be perfected for returning a contained Martian sample to a rigorously controlled terrestrial microbiology laboratory. But the reliability of such a return system would have to be demonstrated to the satisfaction of representatives of the whole Earth: back contamination is not an issue confined to any one nation.

For myself I would urge a vigorous program of unmanned exploration of Mars with roving vehicles, deferring the more expensive and possibly dangerous returned sample and manned missions to a later time.

But if we humans do not destroy ourselves through stupidity, greed or political miscalculation, I am confident that there will be such a later time—a period where remoter worlds in the solar system are being explored by intelligent roving vehicles, the descendants of the first Vikings; a time when at least serious consideration is being given to the possibility of establishing human outposts on other worlds, the chief of which is likely to be Mars. People of that time will look back to this, I think, in the same way that we in America look back to the first voyages of exploration and discovery in the "New World." In fact the year of Viking is auspicious. It is the 500th anniversary of the first glimpse of the great untraversed Atlantic Ocean by a young Genoese sailor named Christopher Columbus. I believe that the ultimate historical importance of Viking, if it succeeds, is comparable to that of the *Nina*, the *Pinta*, and the *Santa Maria*. ■ ■ ■ ■

## Epilogue

*by Dr. Carl Sagan*

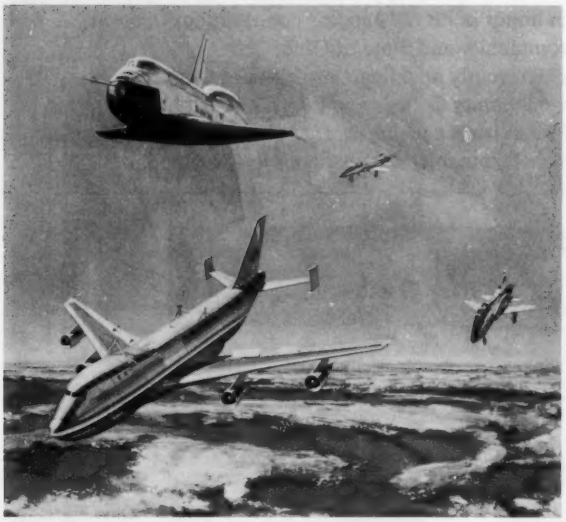
The preceding six articles were completed in the spring of 1976, before Viking 1 and 2 had arrived at Mars. We have since seen a spectacularly successful mission, with two orbiters and two landers still functioning superbly well and transmitting data over hundreds of millions of miles of interplanetary space.

Very important information has been obtained on the atmospheric composition of Mars, strongly implying that the early atmosphere was much denser than the contemporary atmosphere and helping us to explain the martian river valleys, whose nature has been elucidated by Viking orbital photography. The brick-red surface of the planet turns out to be composed of something like an iron-rich clay. Great boulders are evident everywhere in both Viking 1 and Viking 2 landing sites; drifts of sand and dust blown about by the winds are apparent; and fine particles suspended in the atmosphere from previous dust storms produce a pinkish or creamy orange sky.

The meteorology experiment has worked extremely well and weather reports from Chryse Planitia did appear, as I had hoped they would, on American television weather reports in the summer and fall of 1976. No large organisms have been found in the two sites examined by the Lander cameras, over an area that represents one 10-millionth of the surface of the planet.

The microbiology and organic chemistry experiments, as of this writing, have produced extremely important but enigmatic results. Microbiology on Mars is by no means excluded; but the possibility that these results may be explained by non-biological chemistry is being actively investigated.

Viking has already provided puzzles, surprises and delights, and with a future lifetime measured in months to years, promises to continue revolutionizing our knowledge of the planet Mars. The full range of data, but particularly the color stereo photographs taken by the Landers, speaks eloquently for a future rover mission on the surface of the planet.



**Space Shuttle Maneuvers**—Two artists' renditions of how the Space Shuttle and orbiter will take off and separate in flight. In the first photograph, the Boeing 747 carrier aircraft takes off with the orbiter mounted on its back. The second view shows separation in air, after which the orbiter will make an approach maneuver, then go in for a landing on the lake bed at the NASA Dryden Research Center. The tests will permit study of aerodynamic flight characteristics. The 747 aircraft also will be used to transport the orbiter from the Rockwell final assembly and checkout facility at Palmdale, Calif., to operational launch and landing sites at the Kennedy Space Center and at the Vandenberg Air Force Base in California. Space Shuttle testing will begin in mid-1977.

## Solar Heating Demonstration Begun

One of the first of a group of 32 commercial solar heating and cooling systems in the Energy Research and Development Administration's nationwide solar energy demonstration program recently went into operation in Lynchburg, Va.

The solar heating and hot water system is installed at the office of Terrell E. Mosely, Inc., in Lynchburg, to demonstrate the potential for practical, economic and efficient use of solar energy. NASA's Marshall Space Flight Center is providing technical management for this and other sites in support of the ERDA program.

Businessmen, engineers, architects, and local and state government officials attended the open house to view the installation.

Other installations throughout the country, featuring solar heating, cooling and hot water or various combinations of these, are scheduled for completion in the coming months. All 32 sites should be in operation by about the end of 1977.

The 32 projects were selected from 308 proposals submitted in response to a solicitation issued by ERDA in the fall of 1975. They include 10 office buildings, four schools, three hotels or motels, two fire stations, two factories, one hospital, one laboratory, one library and miscellaneous other buildings.

The amount of federal funding involved in each of the cost-sharing contracts ranges from several thousand dollars to more than a million.

In a related development, the first data collection unit in the centralized, nationwide network for monitoring efficiency and performance of solar heating and cooling systems recently went into operation, sending data to NASA for ERDA.

The unit, called the Site Data Acquisition System (SDAS), began daily transmission of performance data from the solar heating and cooling system demonstration at the George A. Towns Elementary School in Atlanta, Ga.

The Towns Elementary School accommodates 500 students and operates throughout the year, including summer months. A large-scale solar system for heating and cooling the school was added into the original heating system last year with solar collectors mounted on the roof of the building.

The raw data is received, processed and printed out by a central data processing facility at the IBM Co. in Huntsville, Ala., under contract to the Marshall center.

The data-collection network is concentrated on performance and climatic information, including factors such as temperature, humidity, wind, available sunlight, collector inlet and outlet temperature, flow rates and the performance of the energy storage system.

Periodic analytical reports will be provided to the ERDA Technical Information Center at Oak Ridge, Tenn., for distribution to users.

The reports will provide information on solar energy available, solar energy utilized for space heating, cooling and domestic hot water, and other factors describing system efficiency and possible fuel savings.

Two independent studies assured ERDA that this type of centralized network guarantees a high degree of uniformity of data from widely dispersed sites.

The demonstration project, which began in late 1975, is a project of the Westinghouse Electric Corp. and the Georgia Institute of Technology under a cost-sharing no-fee contract with ERDA.

## NASA Scientist Heads NTA

Dr. Julian M. Earls, chief of the environmental health office at NASA's Lewis Research Center, has been elected national president of the National Technical Association, the oldest minority scientific and technological organization in the country.

Founded in 1925, NTA now has chapters in 18 U.S. cities. The association provides forums for the exchange of information among blacks in the technical professions; collects and disseminates information to blacks concerning opportunities in the technical field; aids black youths in preparing for technical careers; and works to remove barriers in the technical profession because of restrictions based on race, sex or religion.

Earls was instrumental in organizing the Cleveland chapter of NTA, and served as its president until he recently became national president.

He joined NASA-Lewis in 1965 and was promoted to chief of health physics section three years later to become, at 24, one of the youngest managers in NASA's history. He has held his present position since 1972. His office is responsible for controlling hazardous factors in the work environment by evaluating the biological and radiological materials present at the Lewis center.

Earls holds four degrees: a Bachelor's degree in physics from Norfolk State College; a Master's degree in physics earned eight months later at the University of Rochester; a Master's degree in environmental science from the University of Michigan; and a Ph.D. degree in radiation physics from the University of Michigan. The three advanced degrees were won by Earls in only 16 months spent on university campuses.

Earls is listed in "Outstanding Young Men in America," "Distinguished Young Black Americans," and in "Who's Who Among Students in American Universities and Colleges." He has received numerous awards for academic and professional excellence including a resolution passed by the Ohio House of Representatives in honor of his outstanding contributions to the community and State of Ohio.

Currently an adjunct professor at Cuyahoga Community College and Cleveland State University, Earls also is a member of, or chairman of the board of, nine community organizations in Cleveland.

**Hispanic Award Presented to Dryden Employee**—Dora Borjon recently was given the Los Angeles Area Federal Executive Board's Spanish Speaking Program Coordinator Award. California Congressman Edward Raybel made the presentation at the Dryden center during National Hispanic Heritage Week. Borjon has assisted many Spanish-speaking students toward participation in various regional educational programs; she has helped them find housing; and she has repeatedly provided holiday dinners in her home for students away from home. She also has helped to increase participation by Spanish-speaking individuals in special programs sponsored by the center's affirmative action plan. Mrs. Borjon received the Dryden center's community service award earlier this year for her work with local Hispanic groups.

## JSC Women Take Astronaut Medical Exams

Cardiologist Dr. R. L. Johnson is conducting tests on female volunteers at the Johnson Space Center, in an effort to determine whether men and women react differently to treadmill exercises and to decreased lower body pressure. Johnson, working for the Cardio-pulmonary Laboratory, is asking JSC women to submit to various tests so that he can obtain baseline data before NASA recruits its first female astronauts for Space Shuttle duty.

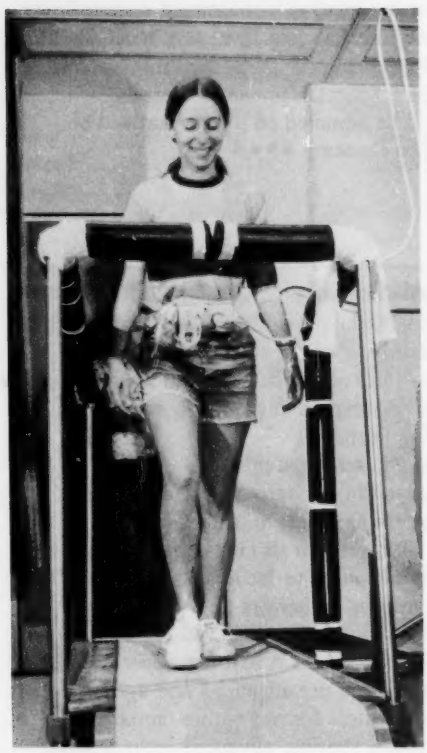
The doctor said that many male subjects have been tested on both the treadmill and the body pressure device, but few women on the former and none on the latter. He added that both tests will be used in the selection of pilots and mission specialists in the Shuttle program.

By testing female volunteers, Johnson said, the center "hopes to furnish information that's really a background for some of the selection criteria used for women astronaut applicants." He seeks Civil Service women of all ages for testing, but will limit the number participating by age groups.

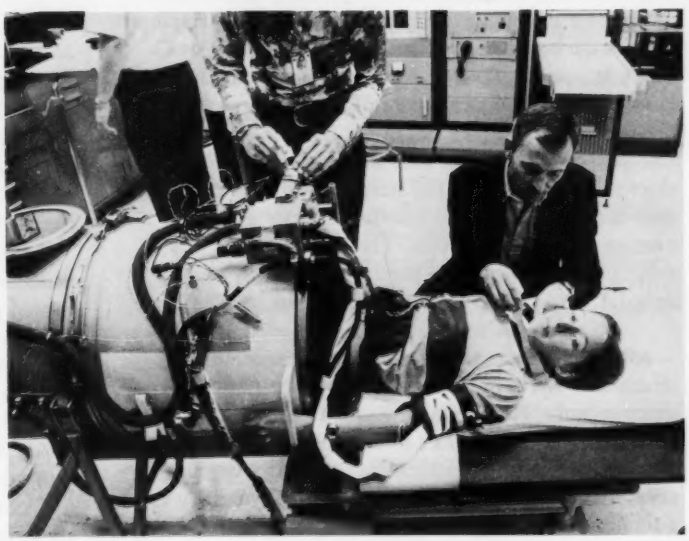
On the treadmill test, the speed and elevation of the moving belt is varied while the test subject's heart rate and blood pressure are monitored. The blood pressure device encases the subject from the waist down. Pressure in the chamber then is reduced and the reaction of the cardiovascular system to the pressure change is recorded for later study.

"During the course of these tests—which take about two hours—we will take electrocardiograms and vector-cardiograms and some tests that evaluate heart sounds and mechanical efficiency of the heart," Johnson said. "These provide a pretty efficient cardiac evaluation."

He hopes to find volunteers who will make a long-term commitment to the program and he expects to repeat the tests on the same subjects at three- to six-week intervals. A prerequisite for participation in the program is a physical examination at the NASA clinic.



**On a Treadmill for Space Tests**—Marsha Ivins, a JSC employee, is wired to the computer-assisted system for exercise as she begins testing at a moderate walk. A nearby machine controls the speed and elevation of the treadmill as a physiologist and bio-engineer study the monitor of the exercise system, which displays on a screen an electrocardiogram and records of heart rate and blood pressure.



**Blood Pressure Testing**—Engineer Marsha Ivins lies encased in the cylinder of the lower body negative pressure device. Dr. G. W. Hoffler, of the Johnson Cardio-pulmonary Laboratory, attaches a pulse sensor to her carotid artery as technicians stand by, ready to begin testing. Pressure inside the cylinder is reduced in increments and resultant changes in heart activity are monitored and recorded.

# Did You Know?

**The Martin Marietta Corporation** has devoted the latest issue of its house publication, *Today* (#3), to NASA's Viking project. The volume, entitled "Viking: Intellect and Ingenuity Triumphant," contains photographs, cartoons, anecdotes and articles reprinted from many sources. Among the random notes: "Harry Winston, a New York jeweler who has catered to the carriage trade since long before it became known as the jet set, foresees perhaps a new set evolving. In any case, the firm announced it has decided on a name for a new 17-carat gem, 'Martian Red.' It's described as a tapered pink diamond. The price tag: only $500,000." A limited number of free copies of the publication may be obtained by writing F. M. Philips, Editor, Martin Marietta *Today,* Martin Marietta Corp., 6801 Rockledge Dr., Bethesda, Md. 20034.

**Dr. Fletcher congratulated the Johnson Space Center** recently for exceeding the federal safety goal for employee injuries during 1975. In a letter to Dr. Christopher C. Kraft, Jr., center director, Fletcher pointed out that the lost-time injury frequency rate of 0.06 was substantially below the 1976 federal goal of no more than 0.2 lost-time injuries per 200,000 man-hours worked. Figures show that during 1975, JSC personnel worked 6,786,861 man-hours with only two lost-time injuries among an average of 3,923 employees. The eight days lost as a result of the two accidents produced a severity rate of only 1.17 days lost per million man-hours worked.

**After eight days in orbit,** two Soviet astronauts returned to Earth in late September in their Soyuz 22 space capsule. Their mission was a joint East German-Soviet venture, a precursor to a series of flights that will ultimately include astronauts from other Communist allies. A key piece of equipment aboard Soyuz 22 was a sophisticated East German camera, designed to photograph the surface of the Earth in "six spectral ranges," according to TASS. Photographs apparently were taken of territory in East Germany and the Soviet Union for geological and geographic research with economic overtones.

**Three employees of NASA's Ames Research Center** recently received Federal Employee Community Service awards, for recognition of volunteer services to the community. Recipients were: Zelda M. Ballantine, a secretary for 13 years at ARC; John P. Kirkpatrick, 11 years at Ames, presently serving as assistant chief of the systems development branch; and Thomas M. Walsh, a 20-year veteran, working as an aerospace engineer in the avionics systems branch.

**A fuel-saving concept** for commercial subsonic transport aircraft will be evaluated under contracts being negotiated by NASA with the Boeing Co., Seattle; McDonnell Douglas Corp., St. Louis; and the Lockheed Aircraft Corp., Burbank. Each firm has estimated its cost at about $1.6 million.

**An announcement of opportunity** has been issued for scientists worldwide to propose experiments for the second Spacelab mission. Spacelab 2, for which the Marshall center has mission management responsibility, is scheduled for launch in late 1980 as a Space Shuttle payload. Unlike Spacelab 1, the second mission payload will not include a Spacelab pressurized module—instead, instruments will be mounted on pallets that will be exposed to space elements. ■■■■

## Professional Society Expands

On Oct. 1, 1976, the previously titled "Technical Council on Aerospace of the American Society of Civil Engineers" will obtain full division status. The new unit, called the "Aerospace Division," is established for the following purposes:

To stimulate and serve the interests of ASCE members employed in the aerospace industry and related government agencies; to foster activities and programs of interest to all civil engineers involved with aerospace activities; to facilitate the transfer of aerospace engineering endeavors and technology to appropriate divisions, councils, and the membership of ASCE; and to coordinate ASCE aerospace activities with other professional organizations and agencies.

Technical committees formed within the new division are keyed to remote sensing, advanced technology, aerospace energy systems, aerospace environmental systems, advanced data collection and management, and aerospace structures and materials. These committees are not yet fully staffed. ASCE members or others interested in serving on a committee, or who wish additional information should contact Richard L. Sauer, (NASA-JSC, DE5, Houston, Texas 77058) telephone (713) 525-5031.

## Lunar Sample Exhibits

*The following is a schedule of lunar sample exhibits from Nov. 15 to Dec. 15:*

**Utah**—The American Space Effort, Salt Lake City, Oct. 29 to Dec. 6.

**Mexico**—State of Coahuila (USIA), Nov. 19-29.

**Texas**—Houston Museum of Natural Science/History, end of Caroline at Hermann Park, Houston, Nov. 15 to Dec. 15.

**American Freedom Train**—South Carolina: Charleston, Nov. 15-18; Georgia: Savannah, Nov. 19-21; Florida: Tallahassee, Nov. 23-24; Jacksonville, No. 26-29; Gainesville, Nov. 30 to Dec. 2; Orlando, Dec. 3-5; Lakeland, Dec. 6-8; St. Petersburg, Dec. 9-12; Sarasota, Dec. 13-15.

**High Flight Bicentennial Mobile Space Museum**—Hampton, Va., Nov. 14-21; Indianapolis, Ind. Nov. 26-28.

**Tennessee Valley Assn.-Bicentennial Caravan**—Mississippi—Brookhaven, Nov. 16; Biloxi-Gulfport, Nov. 17-19; Hattiesburg, Nov. 20; Laurel, Nov. 21-22; Meridian, Nov. 23; Columbus, Nov. 24-25; Tupelo, Nov. 26; Corinth, Nov. 27.

**Long Term Displays**

**Alabama**—Alabama Space and Rocket Center, MSFC, Huntsville

**Florida**—Visitor Information Center, KSC

**Kansas**—Eisenhower Library, 200 S.E. 4th St., Abilene

**Mississippi**—NSTL, Bay St. Louis

**New York**—United Nations Building, New York City

**Ohio**—USAF Museum, Wright Patterson AFB; Visitor Information Center, LeRC.

**Texas**—Johnson Library, University of Texas, Austin; Visitor Information Center, JSC, Houston

**Virginia**—Visitor Information Center, JSC, Houston

**Washington, D.C.**—National Geographic Museum; Smithsonian Institution, National Air and Space Museum, Independence Ave., S.W.; Washington National Cathedral.

## Radio-Television

(*Released nationally*)

RADIO: Four weekly *Space Story* programs have been released —"Space Age Fire Watch" (feat. Dr. Henry Lum); "The Space Shuttle" (feat. William Green); "Project Fires" (feat. Aubrey Smith); "Space Manufacturing" (feat. Professor Gerard O'Neill).

TELEVISION: A 4½-minute and 90 second film have been released in the *Aeronautics and Space Report* monthly series, entitled "Space Shuttle."

## Launches for 1976—Completed and Projected

| Name | Launch Date | Vehicle | Range | Mission Remarks |
|---|---|---|---|---|
| Helios-2 | Jan. 15 | Titan/Centaur | ETR | Scientific satellite to investigate the properties of interplanetary space close to the Sun. Cooperative with Germany. |
| CTS | Jan. 17 | Delta | ETR | Experimental high-powered communications satellite. Cooperative with Canada. |
| Intelsat IVA-F2 | Jan. 29 | Atlas/Centaur | ETR | Comsat communications satellite—reimbursable. |
| Marisat-1 | Feb. 19 | Delta | ETR | Comsat maritime communications satellite—reimbursable. |
| RCA-B | March 26 | Delta | ETR | Second RCA (Satcom) domestic communications satellite—reimbursable. |
| NATO-III A | April 22 | Delta | ETR | Communications satellite for the North Atlantic Treaty Organization—reimbursable. |
| Lageos-1 | May 4 | Delta | WTR | To demonstrate space techniques that will contribute to the development and validation of predictive models for earthquake hazard alleviation, ocean surface conditions and ocean circulation. |
| Comstar-1 | May 13 | Atlas/Centaur | ETR | Domestic communications satellite for Comsat—reimbursable. |
| Air Force Test | May 22 | Scout | WTR | USAF scientific payload—reimbursable. |
| Marisat-B | June 9 | Delta | ETR | Second Comsat satellite to provide maritime satellite communications service—reimbursable. |
| Relativity | June 18 | Scout | Wallops | Scientific probe to test the Einstein Theory. |
| Indonesia-A (Palapa) | July 8 | Delta | ETR | Indonesian communications satellite—reimbursable. |
| Comstar-2 | July 22 | Atlas/Centaur | ETR | Second domestic communications satellite for Comsat —reimbursable. |
| NOAA-5 | July 29 | Delta | WTR | Operational meteorological satellite of the National Weather Service to provide day and night cloud cover imagery—reimbursable. |
| Navy Transit | July 30 | Scout | WTR | Navy navigation satellite—reimbursable. |
| Marisat-C | Oct. 14 | Delta | ETR | Third Comsat satellite to provide maritime satellite communications service—reimbursable. |

## Patents for Inventions from NASA Research

*The Office of General Counsel, NASA headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.*

| Inventor(s) and Employer(s) | Title & NASA Docket | Patent No. | Installation |
|---|---|---|---|
| John Houseman, Donald J. Cerini, Caltech/JPL, Pasadena, Calif. | Hydrogen-Rich Gas Generator | 3,982,910 | NRLO |
| John L. Power, NASA/LERC | Ion Beam Thruster Shield | 3,983,695 | LERC |
| Charles G. Miller, James B. Stephens, Caltech/JPL, Pasadena, Calif. | Cryostat System for Temperatures on the Order of 2 K or Less | 3,983,714 | NRLO |
| Lewis P. Leibowitz, Caltech/JPL, Pasadena, Calif. | Annular Arc Accelerator Shock Tube | 3,983,749 | NRLO |
| John E. Greeleaf, Bill A . Williams, NASA/ARC | Thermistor Holder for Skin Temperature Measurements | 3,983,753 | ARC |
| John E. Roach, Stuart C. Froehling Thiokol Corp., Bristol, Pa. | Casting Propellant in Rocket Engine | 3,983,780 | LARC |
| Roy F. Holmes, Edward E. Keller General Dynamics/Convair, Aerospace Div., San Diego, Calif. | Heat Exchanger | 3,983,933 | MSFC |
| James C. Patterson, Jr., NASA/LARC | Wingtip Vortex Dissipator for Aircraft | 3,984,070 | LARC |
| Jon T. Eliason, Speery Rand Corp., Huntsville, Ala. | Photovoltaic Cell Array | 3,984,256 | MSFC |
| John H. Painter, NASA/LARC | Anti-Multipath Digital Signal Detector | 3,984,634 | LARC |
| Richard E. Haskell, Oakland Univ. Office of Research Sciences, Rochester, Mich. | Optical Process for Producing/ Classification Maps from Multi-spectral Data | 3,984,671 | JSC |
| Wesley T. Huntress, Caltech/JPL, Pasadena, Calif. | Ion and Electron Detector for Use in an ICR Spectrometer | 3,984,681 | NRLO |
| William C. Cliff, Werner K. Dahm, Robert M. Huffaker, NASA/MSFC, Michael C. Krause, David J. Wilson, Thomas R. Lawrence, Lockheed Mis. & Space Co., Huntsville, Ala., James A. L. Thomson, Physical Dynamics, Inc., Berkeley, Calif. | Wind Measurement System | 3,984,685 | MSFC |
| James W. Bilbro, Werner K. Dahm, Robert M. Huffaker, Harold B. Jeffreys, NASA/MSFC, Ronald B. Campbell, Jr., Albert V. Jellalian, Wayne H. Keene, Charles M. Sonnenschein, Michael C. Krause, Thomas R. Lawrence, David J. Wilson, Lockheed Mis. & Sapce Co., Huntsville, Ala., James A. L. Thompson, Physical Dynamics Corp., Berkley, Calif. | Focused Laser Doppler Velocimeter | 3,984,686 | MSFC |
| Robert E. Hunter, NASA/GSFC | Method and Apparatus for Neutralizing Potentials Induced on Spacecraft Surfaces | 3,984,730 | GSFC |
| Gene W. Wester, Caltech/JPL, Pasadena, Calif. | DC-to-DC Converters Employing Staggered-Phase Power Switches with Two-Loop Control | 3,984,799 | NRLO |
| Fred R. Minton, Uel O. Graham, Rockwell International Corp., Downey, Calif. | Window Defect Planar Mapping | 3,985,454 | JSC |
| Leopold A. Hein, William N. Myers, NASA/MSFC | Mechanical Thermal Motor | 3,987,630 | MSFC |
| Robert W. Vaughan, Robert J. Jones, TRW Systems Group, Redondo Beach, Calif. | Weld-Bonded Titanium Structures | 3,988,561 | LARC |
| Robert F. Rice, Edward E. Hilbert, Caltech/JPL, Pasadena, Calif. | Space Communication System for Compressed Data with a Concatenated Reed-Solomon-Viterbi Coding Channel | 3,988,677 | NRLO |
| Tage O. Anderson, Caltech/JPL, Pasadena, Calif. | Computer Interface System | 3,988,716 | NRLO |
| Calvin F. Herman, NASA/JSC | Differential Pulse Code Modulation | 3,988,729 | JSC |

## Inventions and Contributions Board Monetary Awards

*The Inventions and Contributions Board, at its meetings of March 24, 1976, and April 29, 1976, recommended that monetary awards be granted to the NASA employees and NASA contractor employees identified below for scientific and technical contributions to space and aeronautical activities. The recommendations were approved by the Administrator and the awards have been made.*

| Innovator(s) | Title of Invention and Contribution |
|---|---|
| **AMES RESEARCH CENTER** | |
| Richard H. Fish, John A. Parker, Robert W. Rosser | Fiber Modified Polyurethane Foam for Ballistic Protection |
| John Dimeff | Self-Calibrating Radiometer |
| Martin Hudis, Theodore Wydeven | Preparation of Dielectric Coatings of Variable Dielectric Constant by Plasma Polymerization |
| **GODDARD SPACE FLIGHT CENTER** | |
| Philip A. Studer | Magnetically Centered D.C. Motor Rotor |
| Paul D. Weir, Thomas S. Johnson | Optical Beam Alignment Fixture |
| Leonard F. Deerkoski, Richard F. Schmidt | Switchable Beamwidth Monopulse Method and System |
| Edward P. Greene | Slip Correction Decoder of Cyclic Block Codes |
| **JOHN F. KENNEDY SPACE CENTER** | |
| Lester J. Owens | Apparatus for Connecting a Prosthesis to Bone |
| Pierce C. Toole | Compact BI-Pulse Coded Modulation Decoder |
| **LANGLEY RESEARCH CENTER** | |
| James S. Hicks, George M. Jurscaga, Thomas P. Kelly | Technique for Foamed In Place Bi-Layer Cryogenic Insulation System |
| Louis A. Brunner, Jr. | A Computerized Construction Specification System (SPECSINTACT) |
| Dr. Reginald E. Exton | Stack Plume Visualization System |
| Dr. Judd R. Wilkins, Stacey M. Mills | Automated Single-Slide Staining Device |
| Robert C. Costen | Smokestack Mounted Airfoil |
| Chase P. Hearn, Richard H. Crouch | Response to Phase Modulator |
| **LEWIS RESEARCH CENTER** | |
| Anthony Fortini, John N. Kazaroff | A Heat Exchanger and Method of Making |
| Lawrence P. Ludwig | Counter Pumping Debris Excluder |
| Henry W. Brandhorst, Cosmo R. Baraona | Solar Cell Surface Treatment |
| John L. Power | Ion Beam Thruster Shield |
| Lawrence H. Thaller | Electrically Rechargeable Redox Flow Cell |
| **LYNDON B. JOHNSON SPACE CENTER** | |
| Ralph E. Drexel, Marion W. Hix | ASTP Rescue Kit Development Award |
| David E. Pitts | Space Mirrors |
| William C. Schneider | Auger Attachment Method for Insulation |
| **BELL AEROSPACE COMPANY** | |
| W. D. T. Davies, Stephen C. Martin | Correlation Type Phase Detector |
| **DEPARTMENT OF TRANSPORTATION** | |
| Dr. Joseph L. Horner | Optical Noise Suppression Device and Method |
| **GENERAL ELECTRIC COMPANY** | |
| Richard Ravenhall, Charles T. Salemme, Arthur P. Adamson | Impact Absorbing Blade Mounts for Variable Pitch Blades |
| George A. Coffinberry, Howard B. Kast | Oil Cooling System for Gas Turbine Engine |
| Donald F. Sargisson, Arthur P. Adamson | Gas Turbine Engine with Convertible Accessories |
| Everett A. Johnston | Variable Area Exhaust Nozzle |
| **HUGHES AIRCRAFT COMPANY** | |
| Julius Hyman, Jr. | Liquid-Metal Cathode with Single-Capillary Flow Impedance |
| William E. McKee | Method of Impregnating Porous Tungsten |
| **JET PROPULSION LABORATORY** | |
| Robert F. Rice, Edward E. Hilbert | Space Communications System for Compressed Data with a Concatenated Reed Solomon-Viterbi Coding Channel |
| **JOHNS HOPKINS UNIVERSITY** | |
| Robert C. Moore | Open Loop Digital Frequency Multiplier |
| **LIFE SYSTEMS, INC.** | |
| Richard A. Wynveen, James D. Powell, Franz H. Schulbert | Iodine Generator for Reclaimed Water Purification |
| **LOCKHEED MISSILES AND SPACE, INC.** | |
| Alexander Pechman, Robert M. Beasley | Ceramic Coating for Silica Insulation |
| **LTV AERO** | |
| Lewis R. Wilson | Response to Phase Modulator |
| **MARTIN MARIETTA CORP.** | |
| Bernard M. Burke, Sr., John R. Lager | A Method for Fabricating Graphite/Epoxy Laminate from Ultrathin Laminate |
| **NATIONAL SCIENCE FOUNDATION** | |
| Ting L. Chu | Low-Cost Substrate for Polycrystalline Solar Cells |
| **ROCKWELL INTERNATIONAL** | |
| William F. Iceland, Edwin L. Whiffen | Refinement Control in TIG Arc Welding |
| Fred R. Minton, Uel O. Graham | Window Defect Planar Mapping Technique |
| **SCOTT AVIATION** | |
| John L. Sullivan, Eugene A. Giorgini, Milo R. Simmonds | Self Contained Breathing Apparatus |
| **SPERRY RAND CORPORATION** | |
| Jon T. Eliason | Photovoltaic Cell Array |
| **TAMARACK SCIENTIFIC COMPANY, INC.** | |
| Ronald E. Sheets | Detector Absorptivity Measuring Method and Apparatus |
| **UNIVERSITY OF VIRGINIA** | |
| Otis L. Updike | Apparatus for Measuring Sorbate Dispersed in a Fluid Stream |

# Are you getting your **1 cent** worth from **NASA**?

## For a penny of your tax dollar, you are getting, among other things

**Weather Tracking to Save Ships and Money**

Guiding cargo ships safely through treacherous ice-choked waters of the Arctic Ocean is an example of how space technology is being used to help solve earthly problems.

A successful three-week demonstration of an all-weather ice information system was recently completed along the western and northern coasts of Alaska in a joint program involving the U.S. Navy, U.S. Coast Guard, NOAA's National Weather Service and NASA's Lewis Research Center.

The North Slope region was selected for the demonstration because it is the site of a high percentage of the serious shipping problems caused by thick ice. Barges often have been weathered in at ports or have had to turn back from scheduled destinations, and ship cargo by other, more expensive means. In 1975, for instance, many barges were trapped in the Arctic ice and others fled south to ice-free waters. Subsequent extra expenses amounted to about $30 to $50 million.

A test demonstration of NASA's remote sensing ice information system was scheduled to determine whether it would be able to alleviate the problem.

A Coast Guard C-130B plane equipped with NASA's side-looking airborne radar system (SLAR) daily flew over the Arctic sea lanes collecting data concerning ice conditions.

As the plane flew over the Arctic, the SLAR system, in combination with other appropriate electronic equipment, was able to collect and transmit in-flight imagery of coastal shipping lanes about 113 kilometers (70 miles) wide.

These data were relayed to a geosynchronous satellite (GOES), from there to a receiver located at Wallops Island, Va., and then to NASA's Lewis Research Center, where the images appeared in real time. After rapid processing, the images were re-transmitted from Cleveland via the joint U.S.-Canadian Communications Technology Satellite (CTS), to Barrow, Alas., where Navy ice interpreters provided navigation charts and to the NOAA National Weather Service/Fleet Weather Facility in Suitland, Md., where an ice forecast was prepared.

After the shipping season ended, the system was used farther north in the Arctic to assist the Coast Guard's ice breaker U.S.C.G.C.. *Glacier.* With the aid of SLAR, *Glacier* was able to operate through ice in no-visibility conditions.

The SLAR system was called completely successful in both demonstrations.

The ice information system came about as a result of a request from Congress to consider whether the Great Lakes could be kept open for shipping year round.

Since the SLAR system was put into use over the Great Lakes, it has aided in keeping shipping lanes open for two full seasons for the first time in history. Eventual gains are estimated to be hundreds of millions of dollars per year.

**Barge steaming** through ice field off Barrow, Alaska belongs to the Crowly Maritime Corp.

NASA

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